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**SOME OBSERVATIONS ON REPRODUCTION,
GROWTH, AND SOCIAL BEHAVIOR
IN THE STELLER SEA LION**

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There have been several papers published recently pertaining to reproduction and growth of the Steller sea lion (*Eumetopias jubata*), notably by Mathison (1959), Fiscus (1961), Mathison, Baade and Lopp (1962), and Thornstein and Lensink (1962). These have all been based on studies made in the northern part of the range of the species. The present account relates to Steller sea lions on or about Año Nuevo Island along the central California coast, which is almost at the southern end of the range of the species in the eastern Pacific Ocean. A few are reported to occur farther south on San Nicolas Island.

Earlier reports on the breeding colony of this species on Año Nuevo Island have been made by Starks (1918), Evermann (1921), and Evermann and Hanna (1925). A summary of these and other papers, as well as a history and description of the area, is given by Orr and Poulter (1965). The observations reported here were made between May 1961 and September 1964, during which time more than 60 days were spent on the island. Although the primary purpose of this project was to study the population cycles of the several species of pinnipeds occupying Año Nuevo Island, considerable additional data on life history and behavior were obtained. Certain aspects of the social interrelationships of the Steller sea lion, the California sea lion (*Zalophus californianus*), the

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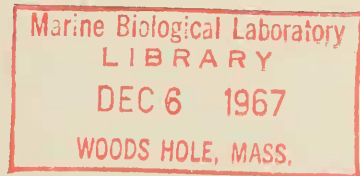




FIGURE 1. Aerial view of Año Nuevo Island. The rocky reefs off the northwestern (upper) and western (left) parts of the island are favored by Steller sea lions. California sea lions are on the beach in the lower part of the picture left of center. Photograph taken in 1953. Courtesy of the United States Coast Guard.

elephant seal (*Mirounga angustirostris*), and harbor seal (*Phoca vitulina*) of the area have already been reported (Orr, 1965).

AREAS UTILIZED

Steller sea lions on Año Nuevo Island stay on the seaward side, where they haul out at any time of year principally on the adjacent rocks to the west and northwest designated as 10E, 10W, 11, 12, 13, 14, and 15 (figs. 1 and 2). Areas 11, 12, 10E and 10W are the first to be selected by newly arrived bulls for the formation of future rookeries. These are sloping or flat rocks that are several hundred feet in length. As the number of bulls increases, areas 7, 14, and even 9 may become rookeries. Bachelors tend to stay on the sandy beach designated as area 3, and in area 2. Areas 1, 4, 5, 6a and 8 may be used occasionally at any time of year by a few individuals.

Although areas 10E, 10W, 11, 12, 13, 14, and 15 are favored throughout the year, heavy seas occasionally force the animals to abandon these exposed



FIGURE 2. Map of Año Nuevo Island. Each major area is numbered.

rocky islets. To cite an example, on 25 October 1966 high seas combined with a strong northwest wind caused waves to wash over these seven hauling-out areas. By mid-afternoon all the Steller sea lions, consisting of 715 females, 35 yearlings, and 390 pups, had concentrated on areas 1, 2, and the extreme south end of 19, where they were mixed with male California sea lions.

The tendency for sea lions that were hauled out to avoid getting splashed was noted many times. An animal being splashed would usually either move to a higher, more protected situation or, if none was available, go into the water.

ADULT MALES

SEASONAL OCCURRENCE. Large males make their appearance on the island by early May, reach a peak in numbers by early July, begin to leave in the latter part of July, and have all departed before the end of August (fig. 3). Included in this category are harem bulls, mature bulls that are unsuccessful in acquiring females during the reproductive season, and subadult males that may be classified as bachelors.

Except during the height of reproductive activities, from early June to early July, it was not possible to separate these three categories of males because of movement of the animals for position in the early part of the season and the gradual subsidence of territorial behavior toward the end of the breeding period. Although the total number of males present in early July was notably higher than in early June, the maximum number of dominant bulls was present by the latter date. In 1962 on 5 June out of a total of 203 large males 101 were bulls with territories, though less than half this number had harems. This was

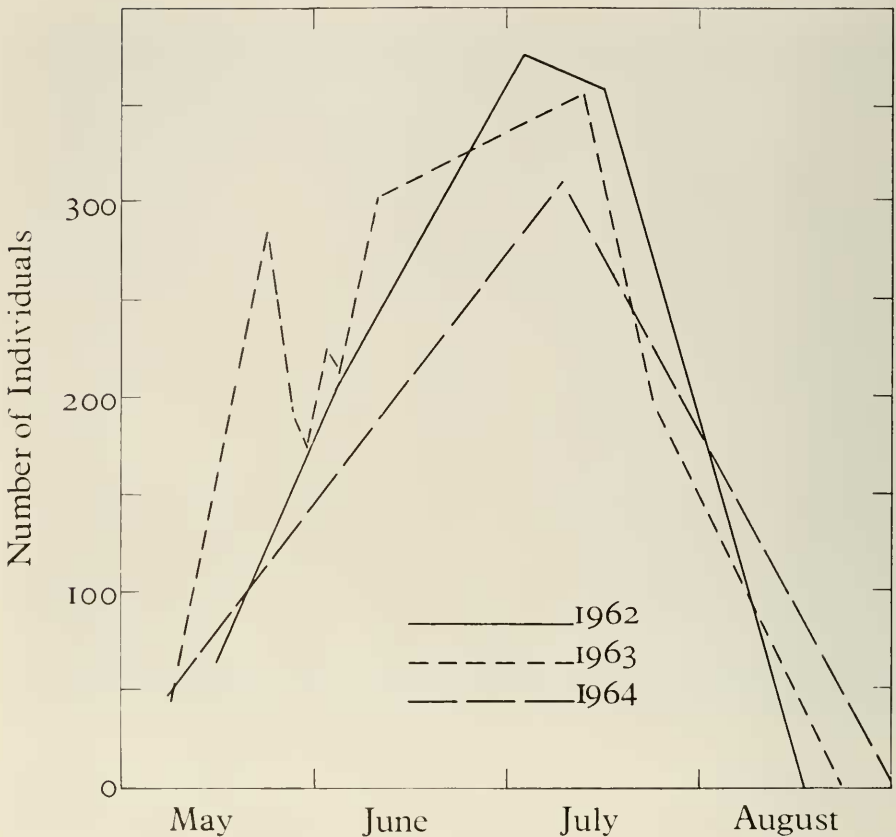


FIGURE 3. Total number of bull and bachelor Steller sea lions on Año Nuevo Island for 1962, 1963, and 1964.

the maximum number of bulls noted that summer even though the total adult and near adult male population rose to 375 by 3 July. In 1963 the maximum number of bulls with territories was 100. This was noted on 4 June when the total male population was 225, although only 45 had harems. The maximum male population observed that year was 356 on 12 July.

These figures indicate that dominant breeding bulls arrive early and are present in maximum numbers by the time about 40 percent of the non-breeding males have made their appearance.

ESTABLISHMENT OF HAREMS. Territorial behavior is manifest by the bulls almost immediately upon their arrival. On 8 May 1963 bulls were noted scattered over reefs that were to be breeding rookeries. Some were well spaced out and much antagonistic behavior accompanied by roaring and nodding of the



FIGURE 4. A Steller sea lion bull attempting muzzle contact with a female in a newly formed harem. Photographed June 1962 by Thomas C. Poulter.

head was noted. No severe fighting occurred, however. The numerous conflicts were more bluff than battle and resembled the type of behavior so often noted among subadult males. Several bulls were seen to try to herd females into their territories, but the latter refused to stay and would soon dash into the water or move to another part of the reef (fig. 4).

Later in May when many territories were established, the behavior of the bulls became more aggressive (fig. 5). Much of the defensive display was exhibited toward wandering bulls approaching rookery areas by water. This was done by roaring and making brief lunges in the direction of the intruder as he came within a few yards of an occupied rookery shore. These lunges seldom carried the defender very far and appeared to be more of a bluff. It did, however, usually succeed in causing the intruder to swim away, although occasionally an aggressive newcomer would come ashore and fighting would ensue. It is interesting to note that Steller sea lion bulls generally seemed to ignore adult male California sea lions (*Zalophus californianus*), which were abundant in the rookery areas until early June when they left Año Nuevo Island.

The earliest date on which any harems were noted in 1963 was on 27 May, when females were noted with bulls on one reef (no. 11). On this date there were 16 bulls and about 170 cows plus some yearlings in the group. The total



FIGURE 5. Two Steller sea lion bulls engaged in combat over territory. Photographed 11 June 1963 by Robert T. Orr.

population on the island on this date was 383, consisting of 194 males, 172 cows and 52 yearlings. Two days later (29 May) the population had increased to 428 and there was more indication of harem formation on this same reef. Only bulls or subadult males were noted in five other areas where harems were present a week or so later. On 4 June the population was 1045. Of this number 225 were bulls or bachelors, 761 were cows, 50 were yearlings, and 9 were pups. Harems were present in four separate areas as follows: 10E, 10W, 11, and 12. On 11 June all six major breeding rookeries on the island contained harems. This included areas 7 and 9.

From the end of May to the middle of July severe fighting often occurred when solitary bulls approached and challenged harem bulls. In such instances each male lunged at his opponent's head and neck, resulting in bloody wounds on the foreparts of the bodies of both participants. The defending bull was often supported by other harem masters who seemed to join forces to fight the intruding male (fig. 6). The latter was defeated in every such instance observed and frequently was forced to run a gauntlet of attackers once he had penetrated the rookery area.

There were also many instances of bluffing. This occurred not only between



FIGURE 6. Two bulls threatening each other with a harem bull, females and pups in the background. Photographed in June 1963 by Richard Jennings.

challenging males and harem masters but between harem masters themselves. On such occasions two bulls would move toward each other, one or both roaring. One, usually the challenger, would suddenly stop when 10 or more feet from his opponent, occasionally turn or move slightly to one side, then drop his head and lie prone as though sleeping. This immediately caused a cessation of aggressive behavior on the part of the other bull.

The adult bulls were all marked with scars on the head and neck and some of them showed marks of former wounds on the back. In many instances the hair became worn off the chest and ventral surface of the body toward the end of the breeding season, probably as a result of abrasion from the rocks on which they maintained their territories for so many weeks (fig. 7).

During the breeding season for Steller sea lions on Año Nuevo Island it was estimated that about 40 percent of the large adult bulls were unable to secure harems and either kept out or on the periphery of the breeding rookeries. These solitary bulls were, for the most part, established on reefs that were completely lacking in females. Such reefs were less favorable for this species than those occupied by bulls with harems. Solitary bulls were usually well separated from



FIGURE 7. On first arrival the underparts of Steller sea lion bulls are well haired. This is largely worn off as a result of abrasion from the rocky reefs before the breeding season is over. Photographed in June 1962 by Thomas C. Poulter.

one another and were not observed fighting on these reefs unoccupied by females. A few bulls without harems were seen on the edges of the breeding rookeries, often close to the water's edge (fig. 8). In 1961 one such bull was distinguished by an open wound, about 12 inches in length, on his left flank and was seen in the same place on 14 June and 27 June. Occasionally a bloodied and defeated bull was seen with a bachelor group or with California sea lions.

At the height of the breeding season bulls with small numbers of cows, usually one to eight, were noted in what might be termed non-rookery areas. These were peripheral situations not favored by the dominant bulls. Sometimes a small harem of this sort was seen on the rocky western shore of the island rather than on the offshore reefs. Most of these females had pups and it was probable that the pups were responsible for these isolated harems. Many pups are washed off the outer reefs by heavy seas at times, and some of these swim to the island or to smaller reefs where solitary bulls are stationed. If they are followed by their mothers, which sometimes happens, they may aggregate with a previously haremless bull.

The spacing between established harem bulls was found to be quite variable. Sometimes bulls, surrounded by cows, were no more than 10 feet apart. Although



FIGURE 8. A Steller sea lion rookery in area 7. Harem bulls are scattered among cows and pups. Two solitary bulls are seen in the lower left. Photographed 9 July 1964 by Robert T. Orr.

they might occasionally roar at one another it was rare that other signs of animosity were exhibited except toward strange males.

As pointed out by Mathison, Baade, and Lopp (1962), the harems are lacking in definitive boundaries and the number of females constituting a harem is quite variable (fig. 10). To cite an example, as previously noted on 4 June 1963 harems were well established in four rookery areas but the ratio of bulls to females in each varied considerably. In no. 10E it was 1 to 3 (15♂♂ to 45♀♀), in no. 10W it was 1 to 9 (4♂♂ to 35♀♀), in no. 11 it was 1 to 31 (14♂♂ to 534♀♀), and in no. 12 it was 1 to 12 (12♂♂ to 146♀♀). The highest ratio of females to males was on reefs 11 and 12, which were the rookeries most favored by females. These were reefs which were separated from the main island.

RELATION TO FEMALES AND YOUNG. Bulls were frequently seen muzzle to muzzle or nose to nose with females in their harems. Under such circumstances the vibrissae were moved forward as in aggressive behavior and the male moved



FIGURE 9. An unattached Steller sea lion bull on a beach with a group of California sea lions. Photographed June 1962 by Thomas C. Poulter.

his nose rapidly over the facial area of the female, sometimes nodding as he did so and keeping his mouth partly open. He also had short, rapid inspirations at such times as though smelling his partner thoroughly. Both would emit low growls. In some instances this behavior appeared to be preliminary to an attempt at copulation by the male. One gained the impression, however, that the female also used muzzle contact as a means of avoiding copulation at times. Attempts to copulate on the part of the male were frustrated by a female maneuvering rapidly to maintain a nose to nose contact.

Attempts at copulation on the part of bulls were frequently noted with the beginning of harem formation, but the females appeared to be unreceptive until their pups were a week or two of age. In 1963 no copulation was observed on 3, 6, or 11 June although some females had given birth to young by the earliest of these dates and numerous pups were to be seen on the last of these dates. Attempts by the bulls were rebuffed by the females and those that had young seemed apprehensive of the latter being crushed by the bulls. Copulation was commonly observed during the latter half of June and first two weeks in July (fig. 11). The time required to complete copulation varied considerably. Two matings that were timed required 5 minutes and 12 minutes, respectively.



FIGURE 10. A harem of Steller sea lions commanded by the bull left of center. A newborn pup may be seen in the lower right. Photographed June 1962 by Thomas C. Poulter.

Bulls were never observed herding females forcefully back into harem areas as has been reported for the northern fur seal (Bartholomew, 1953). They seemed to ignore the pups almost completely. The latter either had to be protected by their mothers or else be alert to avoid being crushed by the large males. On at least one occasion fighting bulls were seen to crush a young pup to death. On another occasion a bull was seen to come to a female that was trying to lift her young pup from a fairly deep tidepool as the surf kept surging over it. In his eagerness to try to entice the female back to the harem area he repeatedly moved over the pup, resulting in the latter's death.

FEMALES

SEASONAL OCCURRENCE. Since female Steller sea lions, unlike males, appear to leave the rookery areas periodically and go to sea during the reproductive season, just as at other times of the year, accurate data on their numbers were not secured. However, counts made at various times over the entire year indicated certain trends (fig. 12). A noticeable decline in numbers was evident in late October. Smallest numbers of individuals were found between January and the end of May. There was an increase in the female population in early June but the largest counts were obtained in July, August, and September. As the



FIGURE 11. A Steller sea lion bull copulating with one of the cows in his harem. Photographed 27 June 1961 by Robert T. Orr.

reduction of the adult female population in winter and spring was correlated with a reduction in the number of young at those times, two explanations seem possible. Either females and young tend to move elsewhere in January or else they spend more time at sea. The former idea seems more plausible.

GENERAL BEHAVIOR. In the rookeries during June and early July the cows appeared to exhibit particular deference toward the bulls. When one of the latter moved about a harem area the females that he approached would try to have muzzle contact with him. Females with small pups would, under such circumstances, attempt to keep the bull away from the pup. Sometimes this involved growling and even biting the male on the neck.

Females were frequently seen to pick up small young by the loose skin of the body, usually the back, when the latter were in danger (figs. 13 and 14). On one occasion a small pup that still had a long piece of umbilical cord attached was observed in a tidepool where it had inadvertently fallen and was being washed every few moments by large waves from the incoming tide. If it became submerged the mother would reach under the water and pick it up by

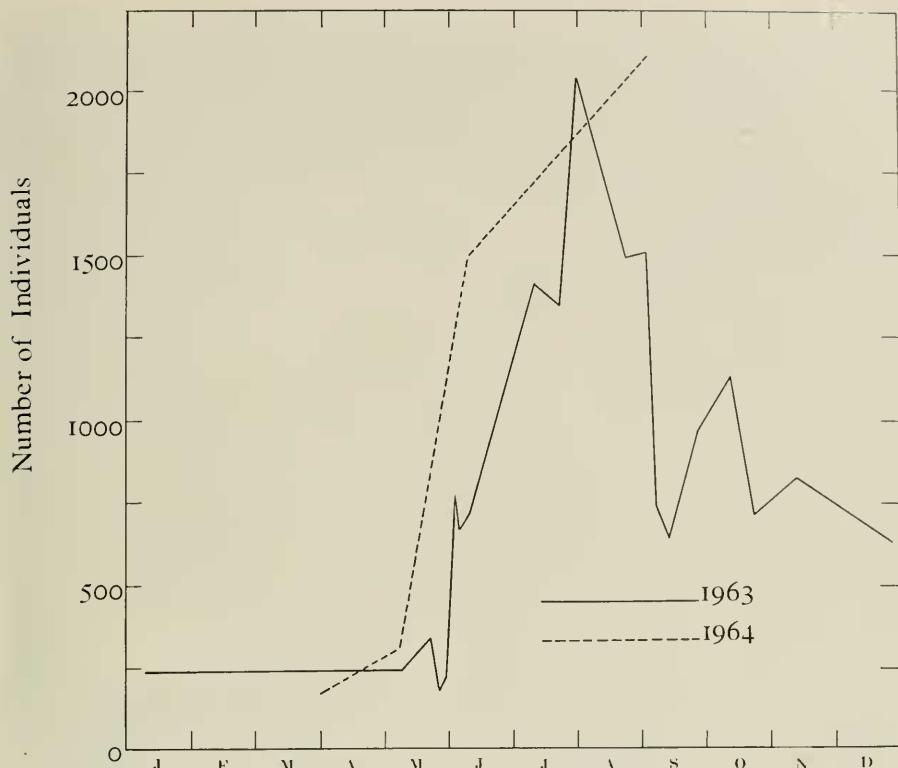


FIGURE 12. Adult female Steller sea lion population on Año Nuevo Island during 1963 and part of 1964.

the back of the neck. Meanwhile the harem bull kept bothering the female with his attentions and at times almost crushed the pup. After this continued for about 15 minutes a particularly large wave washed over the pool. As it did so, the female dove and then surfaced with the young held in her mouth, galloped rapidly up the side of the pool, and deposited her pup high on the reef.

Females that were unreceptive to attempts by a bull to copulate would growl and bite the neck of the male. The bite was not of a violent nature, nor did the bull ever seem to retaliate when so repulsed. Females with small young appeared quite aggressive toward other females that tried to approach them. At such times they would frequently utter a snarl-like growl and attack with their mouths open and teeth bared. The necks of many of the females showed scars (fig. 15). Females were also extremely aggressive toward pups, other than their own, that attempted to nurse them. On several occasions pups were observed to be picked up in the mouths of irate females and thrown 6 to 8 feet in the



FIGURE 13. A female Steller sea lion carrying her pup up out of the water. Photographed June 1963 by Richard Jennings.



FIGURE 14. A female Steller sea lion carrying her pup across a reef. Photographed June 1963 by Thomas C. Poulter.

air. When nursing young the female lies on her side or sometimes almost on her back, often with the eyes closed (fig. 16).

Outside of the reproductive season, females and immatures are often seen in close compact groups or rafts resting on the water from 200 to over 1000 yards from the island. The individuals comprising these rafts may remain together for several hours resting. Even though the rafts drift the animals forming these groups stay very close together with their bodies generally parallel to one another and almost touching. Occasionally a front or hind flipper is raised. When floating in the water in this manner the bodies of Steller sea lions have a decided vinaceous color which is very distinct from the blackish tones of California sea lions that are often nearby or even in the same raft. This group behavior was also noted at times when the sea lions were believed feeding. Synchronous submersion of rafts consisting of up to several hundred individuals was frequently noted when they were half a mile or more out at sea. All individuals would dive within a period of a few seconds and not appear on the surface for several minutes. This type of behavior would be repeated again and again. It is quite similar to the synchronous submersion behavior that is shown by wintering flocks of eared grebes (*Colymbus nigricollis*). A somewhat comparable synchronous feeding behavior is also seen in African pelicans and in flamingos.



FIGURE 15. A sleeping Steller sea lion cow showing the numerous scars often present on their necks. Photographed 11 August 1961 by Robert T. Orr.

Members of a feeding flock of those birds will all submerge the head at the same time. It may possibly enhance the chances of capturing food.

BACHELORS

The term "bachelor" is used here to include males not sufficiently old to secure a harem. Yearlings are not included in this category. The latter could be recognized by their small size, their association with an adult female, and their acceptance in the harem areas. The composition of this non-breeding class, therefore, was believed to range from two-year olds to young bulls nearly mature. Animals of the latter size were distinguished from solitary bulls that had failed to secure harems by their gregariousness. They tended to stay grouped in areas not occupied either by harem bulls or solitary bulls (fig. 17).

Since the outermost reefs and large rocky islets to the northwest of the island were, for the most part, the areas occupied by the breeding population including the solitary males, the non-breeding individuals were forced into situations or habitats that would be considered marginal for this species. These included inner reefs and sandy beaches.



FIGURE 16. Steller sea lion pups nursing their mothers. Photographed July 1962 by Thomas C. Poulter.

Although subadult males spent considerable time sleeping, most of their waking activity was occupied in sort of mock battle. This behavior was observed most often at the water's edge or even when the animals were partly submerged. Young bulls would pair off and go through the act of fighting yet indulge in very little bodily contact. These participants usually faced each other with their mouths open, uttering low roars. Periodically one would lunge at the other, but very little attempt was made to bite the opponent or inflict any sort of a wound. In fact, the necks of these bachelors were notably free from the battle scars which were so conspicuous on the necks of the breeding bulls (fig. 18).

The reaction of these subadult males to human approach was also quite different from that of either harem bulls or solitary bulls. Neither of the latter could easily be frightened away from his territory and might even attack the intruder, as pointed out by Rowley (1929). On the other hand, the subadult males would scare easily and dash as a herd into the ocean when they detected one's presence.

The largest single aggregation of bachelors seen was 200 on 27 June 1961, on beach no. 3. More often, however, they were in small groups on the rocky ledges on the seaward side of the island. As the breeding season approached the



FIGURE 17. A group of Steller sea lion bachelors on the beach in area 3. Photographed 27 June 1961 by Robert T. Orr.

end they were frequently mixed in with Steller pups and cows and newly arrived California sea lions.

YOUNG

The first young normally are not born until the beginning of June. Premature births, however, are not uncommon. On 8 May 1963, several dead pups with part of the umbilical cords attached to them were seen on the beaches and reefs. On 23 May that year a newborn pup that weighed 30 pounds, measured 31 inches in total length, and had 36 inches of umbilical cord attached, was found on the west side of the island, unattended, in a location not used as a rookery (fig. 19). On 25 May it was in the same place and still appeared to be deserted so was removed to the laboratory for care. No other pups were noted on either the 23rd or 25th. The following table shows the numbers counted during the two-week period from 29 May to 11 June 1963:

TABLE 1.

<i>Date</i>	<i>No. of pups counted</i>
29 May	0
4 June	9+
6 June	21+
11 June	105+

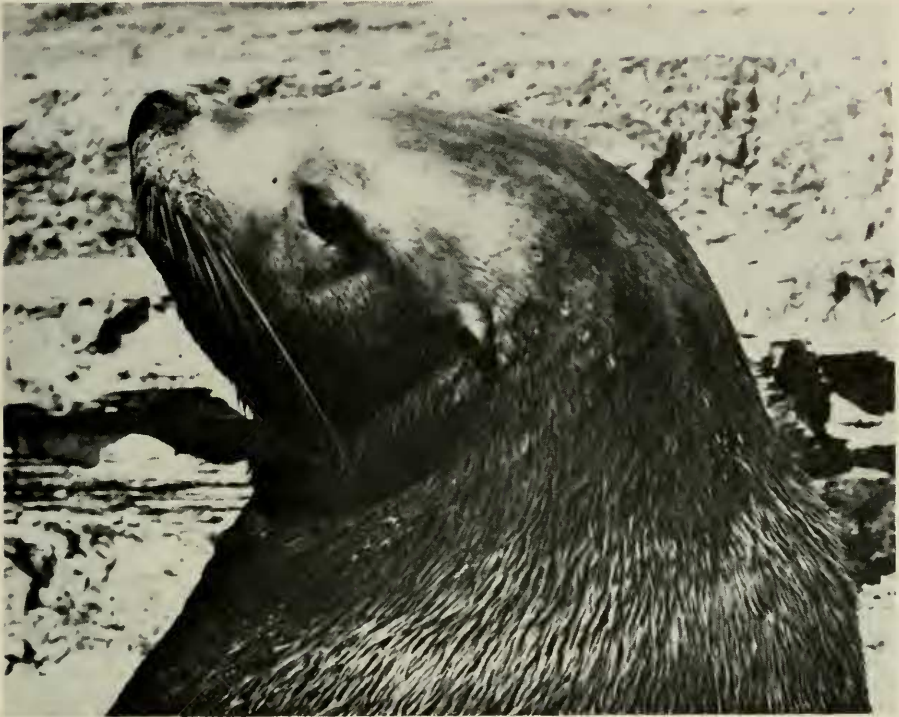


FIGURE 18. Profile of a young Steller sea lion bull. Photographed 23 July 1964 by Robert T. Orr.

Since counts were made from blinds on the shore of the island, the number of young counted was always believed to be considerably below the actual numbers. Many of the pups could not be seen when they were on the far side of adults. An attempt was made to prove this on 23 July 1963 when 150 females and 125 pups were counted on reef 7. Upon scaring the females into the water 210 pups were counted, indicating that approximately only 60 percent of the young had been seen before being disturbed. It also showed that about 30 percent of the females were away from their young on this occasion. The greatest numbers of young counted were 565 on 11 August 1961, 750 on 3 July 1962, and 751 on 23 August 1963. These figures are believed to be far below the actual numbers of young born in each of these years. Difficulty in accurately counting pups on the outlying reefs plus high postnatal mortality lend credence to this belief.

It is probable that young are born until early July. A female was noted that had given birth to a pup a few minutes before on the morning of 27 June 1961 (fig. 20). She was observed moving her muzzle all over the head and body of



FIGURE 19. An early born young that was unattended by its mother. Photographed 23 May 1963 by Robert T. Orr.

the young animal, as though licking it, before and during the passage of the afterbirth which trailed behind her. The latter was eaten by western gulls (*Larus occidentalis*) that almost invariably were around female sea lions at time of parturition (fig. 21). A female was observed giving birth to a pup at this same place on 1 July 1961.

The females generally stay close to the young and *vice versa* until the latter are a week or two old. The voice of pups at this age sounds very much like the bleat of a small lamb in contrast to the notes uttered by the adults. The first pelage of the young is very dark in contrast to the light color of yearlings and adults in the rookery. Small young showed no fear of human approach and would even come and try to climb on one's lap if given the opportunity (fig. 22). Such an experiment was not possible in a harem area, but it was tried with pups that had apparently fallen off rookery rocks and managed to swim to the sloping reefs of the main island.

Occasionally young would fall onto ledges where they had to remain until they attained sufficient size either to climb back up or leap into the sea. One



FIGURE 20. This Steller sea lion pup was born several minutes before this picture was taken. Photographed 27 June 1961 by Robert T. Orr.

young was observed on such a ledge on 10E during the last week of June 1962. A week later on 3 July a young, believed to be the same individual, was seen on the same ledge. The mother looked at it periodically and climbed down so that it could nurse. Considerable vocalization occurred on the part of both the adult and young as she approached. Later on this same day it succeeded in struggling up to the top of the rock, several feet above, where the rookery was situated.

After the pups are several weeks old they begin to gather in groups of four or five to a dozen or more in various parts of the rookery not occupied by the adults, or on the edges of the rookery areas. Here they sleep together in many different positions ranging from prone to supine. The rookery areas almost all contain pools formed from water from waves at high tide. After the young are several weeks old much of their waking time is spent splashing and swimming in these pools (fig. 24). They also engage in mock battles with one another somewhat like those of the bachelors but on a much milder scale. Often a single small pool will contain 20 to 30 pups. The water in the pools becomes very foul but this seems in no way to deter the activities of the young.



FIGURE 21. A Steller sea lion harem with newborn young. A western gull is waiting for the afterbirths. Photographed 27 June 1961 by Robert T. Orr.

Although the pups spend much time in the splash pools they are quite a few weeks old before they will voluntarily go into the ocean. On 13 July 1961, which was close to the termination of the breeding season, the bulls and cows in several rookeries would move rapidly toward the water when a person frightened them. Although very few of the adults actually went into the water, the pups made no attempt to leave the rookery areas.

By the latter part of July the pups will go into the water and may move from reef to reef. When frightened, however, they still tend to stay on the reefs, grouped together, even in early September. By early September they have ceased entirely to use the splash pools and spend most of their waking hours playing and swimming in the water between the rookery reefs as well as in surge channels and about small exposed masses of rocks nearby. They are very adept in the water at this time and swim in groups. On 25 October 1963, a female was seen with five pups following behind. As they progressed toward a rock all would submerge simultaneously, then rise to the surface, following which the female would look back and call once or twice. This behavioral pattern was repeated a number of times until they reached the rock and all climbed out of the water. A similar type of behavior was observed on 21 September 1962 when



FIGURE 22. A young deserted by the mother accepts one of the authors (Poulter) as a substitute within a few minutes. Photographed July 1963 by Richard Jennings.

a small group of pups was seen following a female that was swimming leisurely between some rocks adjacent to the northwest end of the island. They seemed at times to attempt to climb upon her back in the water. She showed no antagonism. On this same day pups were seen on several occasions to annoy some of the California sea lion bulls that were hauled out on some of the smaller rocks. At times groups of them would swarm over the rocks, chasing each other and climbing over the sleeping bulls, which would raise their heads in a threatening attitude if bothered too much (fig. 25). Periodically a pup would leave the group, climb upon one of the larger rocks, and seemingly search for its mother. A number of young were observed nursing their mothers while others were playing in the ocean on this date.

A small number of yearlings was to be found with the females in the harem areas during the breeding season as well as with the females and pups during the succeeding fall and winter. The greatest number noted on any one date was 125 counted on 7 May 1964, at which time there were 305 females, 22 bulls,



FIGURE 23. When the pups are several weeks old they often gather into small groups on the edge of the rookery or in areas unoccupied by adults. Photographed July 1961 by Thomas C. Poulter.

and 25 bachelors. They were observed nursing both in May before the birth of the pups and subsequently. On 23 July 1966 a female was seen nursing a small pup and a yearling at the same time. The latest seasonal date that females were observed to permit these older young to nurse was on 9 January 1963 at which time the immature animals were about 18 months of age. On this same date, however, two females were seen to discourage these older young from nursing.

Mock battles are commonly engaged in by pups when they are a few weeks old. It is likely that these are young males, but this was not determined. It consists primarily in muzzle and neck contact between the two participants as they face each other and is essentially similar to that of the bachelors but on a lesser scale (fig. 26). In mid-winter, young of the year and immatures about 18 months old were occasionally seen to engage in such combat together. The two age groups often played together in the fall and winter.

VOCALIZATION

The vocalization of the Steller bulls can be divided into four categories, each occurring under different circumstances. First, the loud threatening roar, growl,



FIGURE 24. The pups spend much of their time in the tidepools after they are a few weeks old. Photographed 23 July 1963 by Robert T. Orr.

or snort as he challenges another animal; second, the low-level but long continuous signal of an isolated bull with his head high in the air, early in the breeding season before the cows arrive in the rookery area; third, the low-level growling or scolding signal within the harem in which the repetitive fluctuations in tone are synchronized with a nodding of the head; and fourth, their under-water signals and clicks, which like the fur seal and the Weddell seal resemble certain of their in-air signals. The voice of the cows during the breeding season is less forceful than that of the bulls and sounds vaguely like the low bellowing of cattle or the bleating of sheep. The young males and females from a few weeks to several months of age produce a loud, continuous sound resembling a belch. The older the animal the lower the pitch of the signal. Very young pups have a cry which is not unlike the bleating of a small lamb. Sonograms of the characteristic vocalization of the Steller sea lion are shown in figure 27.

Vocalization in this species as in the northern fur seal (Bartholomew, 1959) appears to play an important part in the finding of young by females that have gone to sea and are returning to the rookery area. Females call regularly on



FIGURE 25. By the time the Steller pups are two months old they move from rock to rock and often haul out with California sea lion bulls as well as their mothers. Photographed 18 August 1962 by Robert T. Orr.

approaching the reef on which their pups are located. The latter answer this call and after they are several weeks old may clamber entirely across a reef to meet their returning mothers. Once contact is made, smell seems to play a role in further recognition. Females smell their young and will reject any that are not theirs.

TEETH

The permanent dental formula for *Eumetopias jubata* is $i \frac{3}{2}, c \frac{1}{1}, pc \frac{5}{5} = 34$. This is the minimum number of teeth found in the family Otariidae. A distinct generic character is the presence of a marked space or diastema between the last two upper postcanines (4 and 5). The last upper post-canine, which does not occlude with lower postcanine 5 because of this shift in position, slants posteriorly unlike the first four postcanines, which are slanted slightly forward. As pointed out by Chiasson (1957), it was once postulated by Allen (1880) that this last postcanine in *Eumetopias* is really a seventh tooth rather than the



FIGURE 26. Pups often engage in mock battle with one another. Photographed July 1961 by Thomas C. Poulter.

homologue of the fifth or sixth. Chiasson indicates, however, that: "It seems more reasonable to suppose that the rapid growth and extension of the skull is responsible for the diastema, rather than to explain it by postulating the occurrence of a unique and mysterious seventh postcanine and the suppression of the fifth and sixth teeth of these series."

SEXUAL DIMORPHISM. There is decided sexual dimorphism in the permanent teeth. Although this is most evident in skulls of adults, one can distinguish males from females in young of the year before the crowns have completely erupted on the basis of the larger size in males. As will be seen in table 2 the length of enamel caps of the upper canine teeth is somewhat greater in immature males than immature females. However, with increased age a marked sexual dimorphism with respect to wear is apparent. Males show a relatively small percentage of crown wear whereas in females the wear is great. In most adult female skulls the upper canines also have deep grooves worn on their posterolateral surfaces above the enamel crowns while the lower canines have become rounded. The postcanine teeth of adult females, especially the second, third, and fourth, also show much more wear than is apparent on the same teeth in adult males (table 2).

DECIDUOUS TEETH. The deciduous dentition at or around time of birth in 14

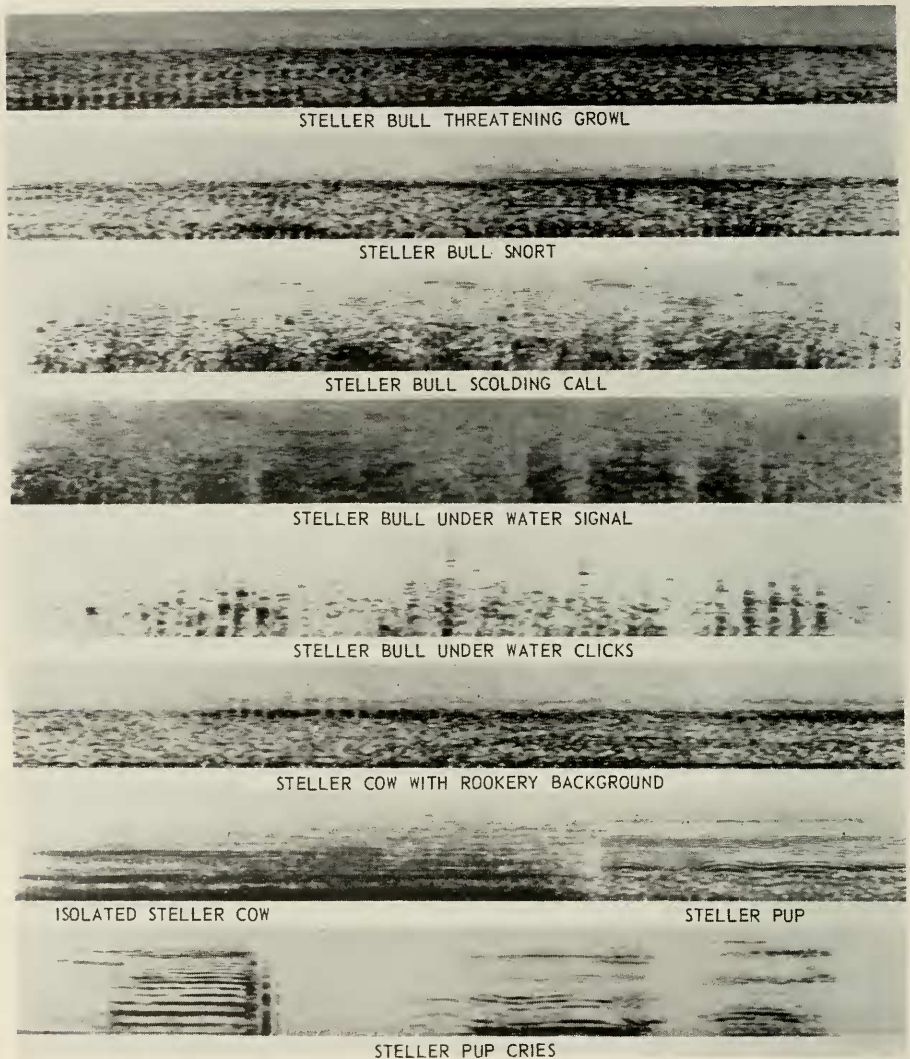


FIGURE 27. Sonograms of adult and young Steller sea lions. Vertical equals frequency, 80 Hz. to kHz. Horizontal equals time, 2.4 sec.

skulls examined is $\frac{i3 \ c \ p2-p3-p4}{i2 \ c \ p2-p3-p4} 10$ (see Spalding, 1966, and Scheffer, 1967).

This is somewhat similar to that noted in the northern fur seal (*Callorhinus ursinus*) by Scheffer and Kraus (1964) although, unlike that species, deciduous incisors 1 and 2 above and 1 (= 2 of Scheffer and Kraus) below are lacking in the Steller sea lion as well as in seven skulls of California sea lion pups taken in June and July on Santa Cruz Island, California.

TABLE 2. *Ratio of crown length (C.L.) of upper canine, as indicated by extent of enamel, to skull length (S.L.) in subadult and adult male and female Steller sea lions.*

Sex	Mus. No.*	Crown length	Skull length	C.L. \times 100/S.L.
♂	16 CAS	35.7	314	11.37
♂	8 CAS	34.1	360	9.47
♂	7659 CAS	35.0	363	9.64
♂	3684 CAS	31.2	375	8.32
♂	1118 CAS	35.0	379	9.23
♂	579 RB	31.2	385	8.10
♂	75 RB	30.0	390	7.69
♀	234 RB	26.5	255	10.39
♀	577 RB	24.5	262	9.35
♀	6064 CAS	22.3	293	7.61
♀	746 RB	25.3	296	8.54
♀	13818 CAS	19.8	297	6.66
♀	267 RB	17.3	299	5.78
♀	71 RB	23.5	299	7.86
♀	56 RB	23.1	304	7.59
♀	13496 CAS	19.0	305	6.23
♀	12872 CAS	24.0	307	7.81
♀	13 CAS	21.0	308	6.82
♀	13819 CAS	19.7	309	6.37
♀	11 CAS	15.5	311	4.98
♀	4413 SU	19.6	312	6.28
♀	1120 CAS	18.0	312	5.76
♀	10 CAS	17.0	316	5.37
♀	1332 CAS	11.5	323	3.56

* CAS = California Academy of Sciences Coll.

SU = Stanford University Coll.

RB = Ray Bandar Coll.

All of the deciduous teeth except the pair of lower incisors are present in the skull of a pup found dead on 23 August. The skulls of four pups, three males and one female, taken in mid-October show the loss of all deciduous incisors, the presence of all canines, and the presence of the first upper deciduous postcanine in all except one of the males. All the lower deciduous postcanines are lost in the female except the last pair.

Judging from these data the first deciduous teeth lost after birth are the lower incisors, followed by the upper incisors, the last two upper and first two lower postcanines. The last deciduous teeth to be lost are the canines.

PERMANENT DENTITION. The first permanent teeth to erupt are I_1^1 . This is followed by I_1^2 , Pc_1^- , and $\frac{5}{-}$. Subsequently I_2^- and all of the other postcanines erupt with Pc_2^2 being somewhat slower than the rest. Incisors $\frac{3}{-}$ and the canines are the last to attain full growth. In two yearling male skulls, taken in June and

TABLE 3. *Steller sea lions, others than young of the year, found dead on Año Nuevo Island and adjacent mainland in 1961 and 1962.*

<i>Date</i>	<i>Sex</i>	<i>Size</i>
1961		
March-April	♀	8 ft. (approx.)
July	♂	10.5-11 ft.
July	?	7 ft.
1962		
June	♀	5 ft.
June	♂	4 ft. (yearling)
July	♀	7.5-8 ft.

July, respectively, the third upper incisors appear fully grown in one but not completely out of the alveoli in the other. In neither are the canines quite half grown. The skull of a male that is at least two years old shows barely half of the crowns of the canines protruding from their alveoli. Both the lacteal and permanent postcanine teeth acquire black pigmentation subsequent to eruption through the gums, so this is a good indicator of sequence.

There is no indication of a diastema between postcanines 4 and 5 in pups during the first summer. One October female shows a 2 mm. space while three male pups taken the same month have diastemas of 3.5, 3.8, and 4.4 mm. In two yearling female skulls spaces of 9.8 and 11.5, respectively, are present. In adult males the diastema may exceed 30 mm. The largest diastema measured in a female is 26 mm.

PARASITES

Two pups that were examined showed signs of heavy infestation by anopluran lice. One pup was captured and held for a few minutes on 26 July 1962. The other was caught and retained for about 30 minutes on 1 September 1962. The latter individual had a total length of 37½ inches and was estimated to weigh 35 to 40 pounds. Its body was very heavily infested with lice similar to those collected from the pup on 26 July. These were identified by Dr. Phyllis T. Johnson of Gorgas Memorial Laboratory, Canal Zone, as adults of both sexes and nymphs of *Antarctophthirus microchir* (Trouessart and Neumann). The lice were almost equally abundant over all parts of the young taken on 26 July except for the undersides of the flippers. Counts made from closeup photographs of selected parts of the body, whose total surface was computed to be 720 square inches, indicated that this one pup had from 25,000 to 50,000 lice. These parasites moved readily from the wet body of the young sea lion to the bodies of its human captors. They had no difficulty in climbing quickly through the fibers of a woolen sweater.

MORTALITY

The young suffered high mortality during the first month or two following birth. However, adults and immatures were occasionally found dead, either on the island or along the immediate mainland coast. Some data for 1961 and 1962 was provided by Mr. Ray Bandar, who periodically patrolled the area during this time (table 3).

During the breeding season bulls occasionally were seen with severe wounds on the body, usually the flanks. It seemed possible that these were inflicted by animals other than sea lions since male sea lions appeared to attack other males only on the head and neck. Both maneater sharks (*Carcharodon carcharias*) and killer whales (*Orcinus orca*) have been noted in this general region. All of the adult males in harem areas had wounds on the forepart of the body but few of the injuries were serious. On 6 June 1963 a solitary bull with a broken jaw which lacked the left lower canine was noted on the edge of the rookery on area 10E. The injury was recent and appeared to have been inflicted in a fight.

Mortality among young, in contrast to adults, was very high during the reproductive season. The principal cause of death was drowning. Drowning was not attributable to inability of the young to swim at an early age but rather a result of their inability, in many instances at least, to find a suitable landing site. Pups would not voluntarily go into the ocean until about two months of age. However, high seas occasionally washed over rookeries in June and July and carried small pups into the water. On 11 June 1963 a large wave was observed to wash eight pups into the sea from one of the rookeries on a rocky reef to the west of the island. They were mostly less than a week old and several had remains of the umbilical cord attached. Some swam toward the island, which was about 200 yards to the east, and managed to land. Others swam about 100 yards toward the island, then turned back toward the reef from which they had been washed or else swam out to sea. All used their flippers and churned up the water as they swam. No doubt a number drowned. Twenty minutes later waves were seen to wash more pups from the same rookery and 15 minutes after this more still were washed away. Five of the young this day landed on the island; four were females measuring 31, 31, 31, and 37 inches. The fifth was a male 38 inches long. Whether the females ever found these young which landed in a rough sea about 200 yards from their rookery was not determined. On numerous occasions young were seen struggling unsuccessfully hour after hour in the water in an attempt to climb back onto a rock while other easily accessible rocks or reefs nearby were ignored.

Rafts of pups that were believed to have died in this manner were frequently seen floating on the water. On 3 July 1962 one such raft contained 10 individuals. On 16 July 1962, 18 dead pups were counted floating between rock 10E and

the island. On this same day the bodies of six pups were seen on a beach in one of the coves nearby. By contrast, on 4 August 1962 very few dead pups were seen in the water or on the beaches and on 18 August 1962 only two dead pups were found floating and only one dead young in fresh condition was seen on the beaches. The latter was a male with a total length of 49 inches. On 1 September 1962 a total of eight freshly dead pups was counted. Most of these were on the beaches.

There may be other mortality factors, however, as deaths in the fall of the year could not be attributed either to drowning or crushing. On 12 October 1963 three dead pups were found on beach 17. Two of these were saved as specimens. Both were males. Their total lengths were 45 and 47 inches, respectively.

The ability of the young to survive in the water by the time they are two and one-half to three months of age was demonstrated on 21 September 1962. On this date we were informed that a Steller sea lion pup had been observed in one of the cisterns two days previous by members of the Division of Beaches and Parks who had happened to visit the island. In the middle of the afternoon of 21 September we found this animal still alive and swimming about in water which was six feet deep. By breaking the top of the cistern so that a hoop net 25 inches in diameter on the end of a long pole could be inserted into the cistern, it was possible to capture the sea lion. The rescue required about one and one-half hours, but the young seemed in good condition although its flippers appeared somewhat waterlogged. No ectoparasites were found. When released the pup was quite pugnacious and attempted to bite. The minimum time that this pup had been in the water was 48 hours.

Crushing of the pups when they were very small by the bulls was the next most important cause of death. This occurred principally in June and early July. As the young became larger they became more adept at avoiding mishaps of this sort and tended to keep in groups apart from the adults much of the time so that they were in relatively little danger. The death of one pup was observed on 13 July 1961 when three established bulls in the rookery in area 7 attacked a challenging bull. The pup was unable to move fast enough to avoid being crushed by the body of one of the fighting males.

Most of the dead and somewhat flattened young on the rocks in the rookery areas were believed to have died in a somewhat similar manner, although other causes, including desertion by or death of the mother, no doubt were responsible for some of these losses. Even on 7 September 1961 three recently dead pups were seen being eaten by gulls on area 10. This was almost a month after the last of the bulls had left. On 13 July 1961 when the death of the pup described above was witnessed, five other dead young were also seen in the same rookery, which had a breeding population of 140 cows and 10 bulls. On an

adjacent beach, however, were the bodies of eight other pups which were believed to have died from drowning.

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SUMMARY

From May 1961 to September 1964 over 60 days were spent on Año Nuevo Island along the central California coast. The island has a large breeding population of Steller sea lions and some females and young are present all year. Adult males begin to arrive in early May and start to exhibit aggressive behavior and establish territories on the outer reefs very shortly. Subadult males appear somewhat later and are largely restricted to less favorable parts of the island where they periodically engage in mock battle between themselves. Although some females are present all year around, there is a large influx in early June. The first harems are found in late May and the young are born from early June to early July. Copulation occurs during the last two weeks in June and the first two weeks of July. The adult and subadult males begin to leave the island by the end of July and are all gone about the end of August. Pups stay close to their mothers during the first week or so but when several weeks old begin to play together in tidepools and rest in groups. By mid-September they are playing in the surge channels and areas between reefs. Vocalization appears to play an important role in parent-offspring recognition. Olfaction is of some importance. Pup mortality is greatest from drowning, with accidental crushing by the bulls the next most important factor. Young were noted nursing up to 18 months of age. Ten deciduous teeth are present at birth, the formula being as follows: $\frac{i3 \ c \ p2-p3-p4}{i2 \ c \ p2-p3-p4}$. The canines are the last permanent teeth to attain full growth. This requires several years. There is marked sexual dimorphism in size of teeth and rapidity of wear. The teeth of females show much more wear than those of males.

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